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The Federal Reserve and Market Confidence

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Abstract

We discover a novel monetary policy shock that has a widespread impact on aggregate financial conditions and market confidence. Our shock can be summarized by the response of long-horizon yields to Federal Open Market Committee (FOMC) announcements; not only is it orthogonal to changes in the near-term path of policy rates, but it also explains more than half of the abnormal variation in the yield curve on announcement days. We find that our shock is positively related to changes in real interest rates and market volatility, and negatively related to market returns and mortgage issuance, consistent with policy announcements affecting market confidence. Our results demonstrate that Federal Reserve pronouncements influence markets independent of changes in the stance of conventional monetary policy.

Key words: policy announcement, risk premium, uncertainty, financial conditions

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1 Introduction

> "Fed policy never works solely or even mostly through short-term interest rates. Instead, it operates through a constellation of financial conditions: stock prices, corporate bond yields, commodity prices, exchange rates and most critically ... the appetite for risk."

(Greg Ip, *Wall Street Journal*, January 25, 2016)

Monetary policy typically focuses on the use of short-term rates to achieve policy goals; however, there is a growing consensus that central banks influence a wide-array of asset prices via other means. Pronouncements by the Federal Reserve can express more than the stance of conventional monetary policy, for instance, by relating a new state dependent policy rule or an assessment of the economy. In this paper, we measure the impact of Federal Reserve announcements on a broad array of asset prices. Unlike the existing literature, we allow for Fed communications to impact assets beyond the domain of changing short-term interest rates. Taking this broad view is important: we find that the primary impact of FOMC announcements in financial markets is orthogonal to changes in the near-term path of rates and consistent with the Federal Reserve affecting market confidence.

Our approach studies the structure of excess volatility in asset returns around FOMC announcements. We first document that, even for long maturities, the yield curve is substantially more volatile on announcement days. This additional volatility can be explained by two factors: a regular monetary policy shock, which explains one-third of the excess variation in yields, and a distinct shock that is responsible for the remaining two thirds. We label the latter shock a market confidence shock because of a number of properties it exhibits. The confidence shock primarily affects the long end of the yield curve, but does not shift long-term inflation expectations, consistent with changes in the term premium. Further, it is correlated with various market-implied volatility measures and the stock market, as well as variation in spreads for household and corporate credit products.

We measure these properties using a novel methodology that explicitly allows for multiple communication shocks. We construct policy shocks as the principal components of the excess variation in yields around Federal Open Market Committee (FOMC) meetings prior to 2008. The identification assumption is that, absent the announcement, the covariance structure of yield changes would be similar on those days as on an average day. The difference between the covariance matrices of yield changes on announcement days and on non-announcement days is the covariance matrix of the response of yields to communication shocks; principal component analysis reveals the structure of the underlying shocks. This is an extension of the Rigobon (2003) heteroskedasticity approach, but instead of focusing on a single interest rate we examine the variance-covariance matrix of the entire U. S. Treasury nominal yield curve. Doing so allows us to entertain a broad view of communication because it relaxes the assumption, pervasive in previous studies, that announcements only convey information about the short-term path of rates.[1]

Consistent with our approach, we find that the yield curve is more volatile following FOMC announcements. In the days following an announcement, the variance of yield changes increases across all maturities. The presence of changes in the policy rate is clear: the variance increases five fold for the Fed Funds rate. But the increased variation also extends to long-term bonds. For maturities between 5 and 10 years, there is about a 40% increase in variance.[2] Hence communication also has a significant affect on rates far into the future.

[1]Previous studies have typically focused on a single policy factor related to changes at shorter maturities (see e.g. Gürkaynak et al., 2005a; Nakamura and Steinsson, 2013), and thus assume an announcement effect operates only via short rates.

[2]Related observations of movements in long-term yields after policy announcements appear in previous

But, it is not so large that one can ignore regular fluctuations in those yields. Our method explicitly adjusts for the presence of this variation.

The excess volatility exhibits a strong factor structure with two distinct communication factors. The first factor explains 34% of the variation in yields attributable to announcements and is a standard monetary policy shock. The short rate responds strongly to the shock, and its impact decays with maturity. The second factor plays a more important role, explaining 59% of the variance. This shock has a roughly flat impact across all bonds, even for long maturities. The presence of this second factor suggests a role for communication beyond changing the stance of traditional monetary policy. The post-crisis period, where the short rate is at the zero lower bound confirms this distinct role. In that sample, we find variation consistent with this factor, but no role for the conventional monetary policy shock. Based on the outcome of our analysis, we term this shock a market confidence factor throughout the paper.

To better understand the nature of our two shocks, we study their relation with other asset prices. To estimate the correlation of the policy factors with other assets, we compute the differential covariance of the factors with asset returns on announcement days versus non-announcement days. The first question we ask is wether changes in long-term interest rates are related to shifts in inflation or in long-term real rates. In the inflation-protected Treasury market (TIPS), we find that the confidence factor affects the entire TIPS yield curve, with a higher correlation between the factor and changes to TIPS yields than that between the factor and nominal yields. This suggests that changes to inflation expectations are insufficient to explain the impact of the confidence factor and that the covariance is better explained by changes in the risk premium or in expectations of the long-term real rates. The

papers such as Cochrane and Piazzesi (2002), Gürkaynak et al. (2005a), and Hanson and Stein (2015).

monetary policy shock, on the other hand, has little impact on real interest rates but does lower inflation expectations. The latter is consistent with a negative lead-lag relationship between consumption growth and realized inflation (e.g. Stock and Watson, 1999).

Federal Reserve communication also impacts equity markets. We find that long-term interest rates are negatively related to the aggregate market return on announcement days, but positively related on non-announcement days. This pattern is consistent with changes in long rates signaling increased growth on non-announcement days, but a greater risk premium when caused by the confidence shock. Changes in the Fed Funds rate, and hence the monetary policy shock, on the other hand, do not covary significantly with aggregate market returns on announcement or non-announcement days. This does not imply that monetary policy shocks do not impact any equity returns. For instance, a positive monetary policy shock generates a lower return for value firms relative to growth firms, a pattern not observed for the confidence shock.

The role of the communication shock for long-term bonds and equity returns suggests an impact on risk premia: the result of changes in risk appetite or perceptions of economic uncertainty. To study the latter we turn to various market-based measures of uncertainty. The confidence factor is positively correlated with changes to various measures of aggregate uncertainty. This result holds across various market-based measures of the one month option-implied volatility: for the S&P 500 (VIX), the S&P 100 (VXO) and U. S. interest rate swaps (SMOVE). This relation lends support to the market confidence interpretation, either by communicating information about the state of the economy to market participants or by changing their perception of uncertainty.

Finally, as suggested by credit channels of monetary policy, we consider changes in household and corporate credit conditions. Both rates and quantities are more slow-moving in those markets, so we adapt our methodology to deal with this lower frequency variation. For corporate credit the commercial paper rate for financial and non-financial companies as well as the rate on high yield debt increase following a confidence shock. Interestingly, in those markets, the monetary policy shock has a similar impact. For household credit, the fixed rate mortgage rate increases after a confidence shock and mortgage applications decline. The monetary policy shock also increases rates, although more wuickly than the confidence shock, and results in fewer mortgage applications.

Taken together, these results show that the two communication shocks are not only statistically orthogonal to each other, but have a distinct effect on financial markets. While the monetary policy shock exhibits well known properties given the role of the Federal Reserve as monetary authority, the confidence shock is more unusual. The patterns of response we describe pushes towards an interpretation as shifting market confidence of market participants, affecting risk premia across markets. The large magnitude of its impact suggest it can be a potent policy tool, maybe stronger than standard rate changes. To better understand this role, it appears necessary to enrich our theoretical models of Federal Reserve communication. For instance, a question we cannot answer is whether the shocks we measure are the voluntary result of the communication strategy of the Federal Reserve or a tool it does not control.

After reviewing the related literature, Section 2 outlines mechanisms by which FOMC announcements can affect financial markets. Section 3 introduces our methodology and estimates the announcement shocks. Then Sections 4 and 5 consider the impact of those shocks on other risky assets and credit market conditions respectively. Section 6 concludes.

Related Literature

The key empirical challenge in identifying the effect of the Federal Reserve on asset prices and the economy is that policy changes are endogenous to the state of the economy: monetary policy is set in response to changes in economic conditions. The extant literature has pursued three approaches to overcoming this identification problem: structural vector autoregressions (VARs) (e.g. Christiano et al., 1999), changes in interest rates that are orthogonal to internal Fed forecasts (Romer and Romer, 2004), and high frequency changes to interest rates around FOMC announcements.

This paper follows the third approach. Rudebusch (1998) shows that monetary policy shocks identified as surprise changes in the Fed funds rate around FOMC meetings have little correlation with shocks identified from a structural VAR approach. Kuttner (2001) and Bernanke and Kuttner (2005) use the Rudebusch shock identification to measure the reaction of bonds and of the aggregate stock market to policy shocks, respectively. Our paper takes a different approach to identification of monetary policy shocks: instead of focusing on changes in the price of the front contract in Fed Funds futures, we use differential changes to the yield curve.

As in our paper, Gürkaynak et al. (2005a) argue for a multi-factor structure for monetary policy surprises. Gürkaynak et al. use unexpected changes in the Fed Funds and Eurodollar futures with maturities up to a year to measure a Fed funds shock and a "path" shock. Distinct from their approach, we use changes in Treasury yields up to ten years in maturity and find independent variation in these long-maturity yiels. In this respect, our approach is closer to Hanson and Stein (2015), who measure the response of term premia to changes in the two-year nominal bond yield on announcement days. This identification strategy assumes implicitly that there is only one policy shock and that it is the only source of variation in the yield curve around FOMC announcement dates. We avoid making this assumption by using the Rigobon (2003) heteroskedasticity approach. As argued in Rigobon and Sack (2004), this identification approach requires a weaker, more realistic, set of assumptions to estimate both the policy shock and the response of asset prices to changes in monetary policy than the traditional event study approach.

More recent work uses high frequency changes in interest rates over a 30-minute window surrounding an FOMC announcement to measure monetary policy shocks. Nakamura and Steinsson (2013) perform a heteroskedasticity-corrected version of the high frequency exercise in Gürkaynak et al. (2005a), and use the results to identify parameters in a small-scale New-Keynesian model. Gertler and Karadi (2015) embed the monetary policy shocks identified using this methodology into a structural VAR model of the economy, and find that small shocks to the Fed Funds rate can lead to large movements in credit costs, driven both by changes in term premia and credit spreads. Similarly, Gilchrist et al. (2015) use high frequency changes to the yield on the two year Treasury to measure policy surprise in the zero lower bound (ZLB) period. Notably, Gilchrist et al. also use information contained in changes to the yield on the ten-year Treasury about policy surprise but concentrate on measuring the response to announcements of unconventional monetary policy. Our findings demonstrate that monetary policy announcements affect long rates even outside the ZLB period. Further, we focus on two-day changes in yields rather than high-frequency approach. It is natural to expect a more gradual adjustment process of longer maturity yields to shocks as these instruments are less liquid than their shorter maturity counterparts, and we actually observe that excess volatility subsists in the second day after the FOMC announcement.[3]

[3] Our results are qualitatively similar if we instead measure changes over the one day interval around the FOMC meeting.

2 Potential Determinants of the Impact of the Federal Reserve on Asset Prices

There are several channels by which the Federal Reserve might affect asset prices. The academic literature primarily focuses on conventional monetary policy. That is, the impact of varying the short-term nominal interest rate. However, we also outline the other ways in which the Federal Reserve might influence asset prices.

2.1 Traditional Monetary Policy

The Federal Reserve's traditional policy tool is the use of open market operations to target the overnight borrowing rate for banks (the Federal Funds rate) in a manner consistent with the dual mandate of maximum sustainable employment and stable prices. Since 2008, the overnight rate has been bounded from above by the interest rate on excess reserves rather than open market operations. In either case, the Federal Reserve has the ability to influence the path of nominal interest rates.

Risk-free interest rate. The simplest view of how monetary policy affects asset prices is through changes in the risk-free interest rate. By implementing a target for the Federal Funds rate, the Federal Reserve determines the short-term risk-free rate. Changes in the risk-free rate naturally impact discount rates for all assets and therefore have a pervasive impact on asset prices. The strength of this effect depends mainly on two elements: the horizon at which the asset will pay off and the persistence of changes in the interest rate.

Economic activity. The second channel through which monetary policy can affect asset prices is through changes in economic activity. Economic activity might vary due to nominal rigidities in markets which result in real effects from movements in the Fed Funds rate, for instance Woodford (2011). Another prominent view is that monetary policy affects credit supply, shifting the ability of financial institutions to extend credit Bernanke and Blinder (1988). In either case, variation in economic activity affects the cash flows from financial claims and as a consequence prices.

Uncertainty and risk premia. Beyond the level of economic activity, monetary policy can also affect uncertainty. An increase in interest rate can not only slow down the economy, but also raise uncertainty, because it is hard to predict how badly companies will be hurt by the slow down. Another channel are changes in financial stability. Stein (2012) presents a model where private money creation can lead to an excessive vulnerability to financial crisis and discusses the role of monetary policy in controlling this issue. Those changes in uncertainty should materialize into changes in various measures of real and financial uncertainty, such as volatility indices. Further, they would naturally imply changes in risk premia, an important component of discounting. An increase in risk premia directly lowers the price of risky assets.

Risk premia can also change because risk appetite changes in the economy. The effect of monetary policy on risk appetite can arise for multiple reasons. Hanson and Stein (2015) argue that yield-oriented investors shift their holdings to long-horizon risky assets following a decrease in rates. In equilibrium, this rebalancing pushes the risk premium down. In Drechsler et al. (2014), the nominal interest rate shifts the ability of banks to fund themselves and engage in risky investment, thereby changing risk premia.

2.2 Changes in Policy Rules

The channels described so far focus on conventional monetary policy operating through overnight rates. For most of these channels, a change in the expectation of the short-term path of rates would have a similar effect and Federal Reserve announcements can communicate such news without actually changing the Fed Funds rate target.

But the communication of Federal Reserve can also be about the policy function of the monetary authority rather than its current policy actions. For instance, announcements can contain news about how monetary policy will respond to economic conditions in the future. Ang et al. (2011) studies a model where the coefficients of a Taylor rule change over time, and finds that shifts in the response of interest rates to inflation have a substantial impact on long-term yields.

Related to these changes, the uncertainty about the type of policy conducted about the future can be resolved over time. For instance, people might be uncertain about the extent to which the policymaker is committed to maintaining low inflation. Barro (1986) explores this situation, with the monetary authority strategically trying to hide its type, but where decisions over time reveal it. Both news about the type of policymaker and changes in uncertainty about it are likely to affect asset prices.

2.3 Economic Information

Finally, a third set of explanations for the impact of the Federal Reserve communication on asset prices is that this communication is unrelated to monetary policy. Romer and Romer (2000) argue that the Federal Reserve has superior economic information over participants in the economy, and in particular financial markets. FOMC announcements are a venue to release this information. Of course, this information can take many forms and is likely to affect expectations and the uncertainty of market participants about the future.

A more subtle version of this mechanism is that by providing a clear public release of information, the Federal Reserve creates common information for market participants, and they coordinate their actions around it. Morris and Shin (2002) study such a role for public signals, showing that they can be useful for the economy, but also harmful by crowding out the revelation of private information. Amato et al. (2002) study the implication of those ideas for the context of monetary policy.

3 Estimation of FOMC Announcement Shocks

To identify the impact of policy announcements we compare changes in yields on announcement days to those on non-announcement days. In this section we describe our methodology, outline the data, and summarize our estimates of communication shocks.

3.1 Empirical Model

Our empirical methodology is in the spirit of Rigobon and Sack (2003). We decompose changes in yields into two independent components: a policy component, ε, and a non-policy component, ν. Hence, a change in yield of maturity n at time t can be written as the sum of these two components,[4]

$$\Delta y_t^{(n)} = y_t^{(n)} - y_{t-1}^{(n)} = \nu_t^{(n)} + \varepsilon_t^{(n)}. \tag{1}$$

We cannot directly observe the realization of the policy component on announcement

[4]In order to focus on innovations, we assume all variables are demeaned, which we do empirically. In unreported analysis we consider a broad array of ways to capture changes in means.

days because there is also an unobserved non-policy component. However, given plausible additional assumptions, we can use variances estimates to recover the variance of the policy component. In particular, we make two assumptions: the variance of the non-policy component is the same on announcement and non-announcement days, $\sigma^2_{n,\nu}$, and there are no policy shocks on non-announcement days. We denote the variance of policy shocks on announcement days by $\sigma^2_{n,\varepsilon}$. Given independence between the two components, the variance of the change in yield can be written as the sum of the variances coming from the policy component and the non-policy component.

Therefore, for a yield of maturity n, the announcement and non-announcement day variances are given by:

$$\text{Non-announcement: } \sigma^2_{n,NA} = \sigma^2_{n,\nu} \tag{2}$$

$$\text{Announcement: } \sigma^2_{n,A} = \sigma^2_{n,\nu} + \sigma^2_{n,\varepsilon}. \tag{3}$$

We can subtract the non-announcement variance, $\sigma^2_{n,NA}$, from the announcement variance, $\sigma^2_{n,A}$, to recover the policy variance, $\sigma^2_{n,\varepsilon}$.

We can extend this logic to analyze comovement in the entire term structure of yields. Subtracting the covariance matrix of changes in yields on non-announcement days from that on announcement days results in a policy covariance matrix, Σ_ε. The policy covariance matrix is symmetric and composed of variances on the diagonal and covariances elsewhere.

It is well-known that unconditionally the yield curve exhibits a strong factor structure. Similarly. the policy variance is likely to arise as a result of a few underlying policy shocks rather than a collection of maturity-specific shocks, and therefore to also have a factor structure. We use principal component analysis (PCA) to recover the structure of the policy shocks from the policy covariance matrix. PCA identifies linear combinations, or components, of policy shocks, $f_{i,t}$, and ranks them in order of decreasing importance in explaining the overall variance of policy shocks. The weights are identified up to a scaling factor. We choose this factor so that the policy shocks $f_{i,t}$ have unit variance and choose the sign for ease of interpretation. Based on the contribution of each linear combination to total variance we choose those factors that are most important in explaining the policy covariance matrix.

While PCA expresses the policy shocks $f_{i,t}$ as linear combinations of the maturity-specific $\varepsilon_t^{(n)}$, it still cannot reveal the actual realization of the factors. Since we only observe yield changes but not $\varepsilon_t^{(n)}$ directly, we cannot eliminate the non-policy component, $\nu_t^{(n)}$. Hence, using the PCA weights for component i at time t does not identify the realization of the policy shock. We can only construct contaminated factors $\tilde{f}_{i,t}$:

$$\tilde{f}_{i,t} = \sum_n \omega_i^{(n)} \Delta y_t^{(n)} = f_{i,t} + \sum_n \omega_i^{(n)} \nu_t^{(n)}. \tag{4}$$

We will account for this issue when we examine the relation between our policy factors and other assets.

3.2 Data

We construct a daily yield curve from various sources. We obtain zero coupon treasury yields constructed according to Gürkaynak et al. (2007) from the Federal Reserve Board's H.15 data release. These yields are interpolated from closing market bid yields on actively traded Treasury securities in the over-the-counter market. We consider yields at each annual horizon from one year to ten years. For yields of maturity less than one year, we augment the Gürkaynak et al. yield curve with 3-month and 6-month constant maturity Treasury yields from the H.15 data release. The yields at horizons less than a year are available from 1982 onward and the horizons of more than a year from 1961.

The primary policy rate of the Federal Reserve is the overnight Federal Funds rate. Therefore, in addition to the yield curve, we consider changes in expectations of the Federal Funds target. The Fed Funds rate reflects the average rate at which depository institutions lend funds maintained at the Federal Reserve to other depository institutions overnight. In order to measure changes in market expectations, we use Federal Funds futures contracts traded on the Chicago Mercantile Exchange (CME). Federal Funds futures contracts began trading in 1988. They are written for a specific month and trade at 100 minus the average daily Fed Funds overnight rate for the delivery month. We slightly modify the methodology outlined in Kuttner (2001) to calculate a time-series of daily Fed Funds rate expectations for the front month (i.e. current month).

Our analysis focuses on two-day changes in yields to better capture developments in less liquid, longer horizon bonds. Intra-day evidence, even from shorter maturities, suggests that the market takes time to resolve the impact of FOMC statements (Gürkaynak et al., 2005b). Our methodology contrasts with higher frequency identification methods (e.g. Nakamura and Steinsson, 2013), which look at intra-day trades but focus solely on shorter, more liquid maturities and classic shocks to changes in the Fed Funds rate. We come back to evidence for this choice in the next section.

We compile a list of monetary policy announcement days starting in 1994, the first year that the Fed began to explicitly announce FOMC decisions. Our primary sample runs through 2007 and includes 113 announcement days; post-2007 there are a myriad of atypical policy announcements. Given we are focused on two-day changes in yields, we designate the two-day change following the day of an announcement as "announcement" changes and two-day changes that exclude an announcement as “non-announcement” changes. We exclude two-day changes that fall on announcement days as they likely include some of the impact from a policy shock. Figure 1 illustrates the timing of the “announcement” and “non-announcement” periods.

3.3 Excess Volatility after FOMC Announcements

An implication of our empirical methodology is that yields are more volatile on announcement days versus non-announcement days. If we compare the variance in yields on announcement days to non-announcement days, Figure 2(a), we can see that announcement days in fact are more volatile, consistent with the empirical model. The raw variances of announcement days are above non-announcement days at all maturities from the Fed Funds forward rate to the ten-year treasury yield. In Appendix Figure A1, we show that in addition to be economically significant, these differences are statistically significant by conducting a placebo analysis randomizing the announcement dates.

Subtracting the variance on non-announcement days from announcement days we recover the variance of the policy shock, Figure 2(b). Policy shocks play a prominent role at the short-end of the yield curve. For instance, Fed Funds rate change has 5 times more variance on announcement days. This behavior is consistent with the Federal Reserve being the main drive of changes in the Fed Funds rate. But the policy volatility also remains substantial at longer maturities, even as far as ten years out. For long-term bonds, the policy variance is roughly 40% of the non-policy variance. Communication therefore appears to affect rates far in the future. This evidence also shows the importance of adjusting for the non-policy variance in analyzing policy surprises.

We argued that focusing at a two-day horizon rather than go to higher frequencies is important to fully capture the impact of the announcements on the yield curve. One way to assess whether it is reasonable is to measure the variance of yield changes for each day following the announcement. We do so in Figure 3. While the largest amount of excess variance happens the day of the announcement, there is still substantial excess variance on the second day, and even a small amount in the third day.

3.4 The Two Policy Shocks

The policy surprises at various maturities are likely to result from a few dimensions of communication shocks. The covariance structure of the policy shocks, that we also recover, reveals these underlying shocks. PCA analysis on the policy covariance matrix shows that the variance in the policy component of announcement day yields is primarily explained by two factors. Figure 4 illustrates the contribution of the first three principal components to the policy variance across maturities. The first component is particularly important for longer maturities and explains almost all the variance at the three and four year horizons. The second component primarily explains the shortest maturities, particularly the Fed Funds surprise (0 maturity in the figure), but it also has a modest impact on maturities greater than 6 years. In total, the first two components explain 93% of total policy variance with the first component explaining 59% and the second 34%.

There are several takeaways from examining the loadings of yields on the first two principal components, Figure 5.[5] The pattern of loadings on the second factor f_2 is typical of a standard monetary policy shock: the short rate responds strongly to the shock, and its impact decays with maturity. Hereafter we call this shock the monetary policy shock and normalize its sign so that a positive shock corresponds to a tightening of the stance of

[5] Appendix Figure A2 reports estimates of the weights of factors on the various yields.

monetary policy. The other communication factor plays a more important role, explaining twice as much variance. This shock has a roughly flat impact across all bonds, even for long maturities. The presence of this large second factor suggests a role for communication beyond changing the stance of traditional monetary policy. We call this factor f_1 a market confidence factor, under the view that an increase in long-term rates captures a decrease in market confidence. We substantiate this interpretation in the remainder of the paper.

Robustness

We consider several alternative identification assumptions to verify the robustness of our baseline results. The first considers a different measure for non-policy variance, σ_ν^2. Non-announcement days may contain some news about Fed policy. FOMC members can deliver public speeches or testify to Congress and these communications might reveal information about future monetary policy announcements. To alleviate this concern, we exploit the Federal Reserve Systems communication blackout period. For the seven days prior to a scheduled meeting there is a strict blackout period during which the Federal Reserve System and FOMC members do not communicate with the public. We use these dates as our control group to construct an alternative measure of policy variance.

Indeed, we find that yield volatility is lower on these days, Appendix Figure A3, especially at the longer maturities. As a result policy variance is larger than under the base specification. When we examine the PCA loadings, we find similar patterns as in our base specification. Figure 6 illustrates the PCA loadings based on non-announcement days (*Baseline*) and those based on blackout days (*Blackout*). The loadings have been rescaled so that they sum to one. The second component is almost exactly the same, whereas the first component is similar, but no longer exhibits elevated weights at the 3 and 6 month maturities.

The second robustness check considers a sub-set of announcement days. Some Fed announcements occur between meetings and may be in response to macroeconomic events. We can construct an alternative estimate of policy variance using the 108 announcements that coincide with scheduled FOMC meetings. The timing of these announcements is predetermined and are plausibly exogenous from other macroeconomic events. Figure 6 also displays component loadings for this set of PCA components (*Scheduled*). The first component closely matches the base specification. The second component trends downward from the short maturities, much like the base case, but slightly favors the 3-month maturity relative to the Fed Funds rate.

Finally, we consider the possibility that macroeconomic news unrelated to the FOMC is released on announcement days. We focus on the release of economic indicators related to the labor market and price levels: non-farm payrolls, the unemployment rate, initial unemployment claims, the produce price index (PPI), and the preliminary ("advance") GDP. If any of these releases falls on an FOMC announcement day we exclude the date from the sample. We drop twelve announcement days during the period of interest. Figure 6 summarizes the component loadings for FOMC only announcements. Dropping the FOMC announcement days that coincide with other macroeconomic announcements does not materially impact the factor loadings.

Thus, the policy factors we uncover are robust to other definitions of both the announcement and the control periods. In unreported results, we also estimated the policy factors using one day changes in yields, rather than two day changes, and found the results to be qualitatively similar. We use the baseline specification, with policy factors identified using two-day changes and the full set of FOMC announcement days, in the remainder of our analysis.

3.5 Post-Crisis Policy Shocks

The sample period from 2010 to 2016 is characterized by a persistently low Fed Funds target and a period of quantitative easing. As a result, the variance in the yield curve and the nature of the announcement shocks are different than the earlier sample period. Figure 7(a) illustrates the variance in yields on announcement days and non-announcement days. While the variance in yields is greater on announcement days for each maturity, it is significantly lower at shorter maturities than in Figure 2(a). The difference at shorter maturities is also significantly smaller, resulting in a much smaller announcement shock variance, see Figure 7(b). Relative to the earlier period, policy shock variance is large relative to non-policy variance at longer maturities, suggesting that announcement days are particularly important for understanding variation in long-dated yields during this period.

Unlike the earlier period PCA reveals that over 90% of the variance is explained by a single factor that resembles the confidence factor in the earlier sample period. Indeed, the first factor has a similar pattern of explained variance across maturities, see Figure 8. The second factor and third factors do not easily conform to the pre-2008 factors. Factor 2 is less important for maturities of less than a year and more important for maturity years 2 through 4. The third factor characterizes the variance of short-term maturities and the Federal Funds futures. The decreased emphasis on short maturity yields is consistent with the reduced use of near term yields for policy and reflects the evolution in policy tools away from near term interest rates. Nevertheless, the confidence factor is fairly similar, suggesting that the announcement shock we describe in the earlier period persists in this sample.

4 Impact of Announcement Shocks on Other Assets

To further characterize nature of the policy shocks estimated in Section 3, we estimate their impact on other asset prices. We extend our methodology to measure announcement-day covariance between policy shocks and changes in asset prices, such as yields on inflation-linked bonds, equity returns, and market-implied measures of aggregate uncertainty.

4.1 Measuring the Covariance of Shocks With Other Assets

We extend the methodology of Section 3 to estimate the covariance between asset returns and policy shocks. As with nominal yields, we allow for non-policy variance on announcement days in addition to the impact of the policy shocks. That is, we assume that returns $R_{i,t}$ for asset i at time t are the sum of a non-policy component, $\xi_{i,t}$, and the impact of our two policy factors:[6]

$$\text{Non-announcement: } R_{i,t} = \xi_{i,t} \tag{5}$$

$$\text{Announcement: } R_{i,t} = \xi_{i,t} + \beta_{1,i} f_{1,t} + \beta_{2,i} f_{2,t}. \tag{6}$$

The non-policy component is independent of the policy factors but can covary with the non-policy component of nominal yields, so that $\text{cov}(\xi_{i,t}, \nu_t) \neq 0$.

Recall that the PCA weights reveal the policy factors polluted by non-policy shocks (equation (4)). Hence, the covariance between the asset of interest, i, and the observed

[6]We do not necessarily need to use returns, any variable that is plausibly independent over time can be analyzed with this approach, for instance changes in yields of changes in implied volatility.

factor, $\tilde{f}_{j,t}$, contains a non-policy component as well as the impact of the policy shock:

$$\text{Non-announcement:} \qquad \text{cov}\left(R_{i,t}, \tilde{f}_{j,t}|\text{NA}\right) = \text{cov}\left(\xi_{i,t}, \sum_n \omega_j^{(n)} \nu_t^{(n)}\right) \tag{7}$$

$$\text{Announcement:} \qquad \text{cov}\left(R_{i,t}, \tilde{f}_{j,t}|\text{A}\right) = \text{cov}\left(\xi_{i,t}, \sum_n \omega_j^{(n)} \nu_t^{(n)}\right) + \beta_{j,i}. \tag{8}$$

Assuming the covariance between non-policy shocks is stable over time, we can derive the impact of the policy factor by differencing between the announcement day and non-announcement day estimates.

These covariances can be calculated directly, or operationalized in the form of a regression in which we estimate the differential response of an asset on announcement days versus non-announcement days:

$$R_{i,t} = \alpha_{0,i} + \alpha_{1,i}\mathbb{A}_t + \gamma_{1,i} f^*_{1,t} + \gamma_{2,i} f^*_{2,t} + \beta_{1,i}\left(f^*_{1,t}\mathbb{A}_t\right) + \beta_{2,i}\left(f^*_{2,t}\mathbb{A}_t\right) + \varepsilon_{i,t}, \tag{9}$$

where $\mathbb{A}$ is a dummy variable equal to one on announcement days and $f^*_{1,t}$ and $f^*_{2,t}$ are scaled versions of $\tilde{f}_{1,t}$ and $\tilde{f}_{2,t}$:

$$\left[f^*_{1.t} \quad f^*_{2,t}\right]' = var\left(\tilde{f} \mid \mathbb{A}\right)^{-1} \left[\tilde{f}_{1,t} \quad \tilde{f}_{2,t}\right]'. \tag{10}$$

The gamma terms capture the covariance with non-policy shocks and the beta terms identify the covariation with the policy shocks, as in equations (7) and (8).[7]

[7]To see that the regression recovers the beta coefficients, notice that the coefficient on f^* in a regression of $R_{i,t}$ on f^* conditional on $\mathbb{A}$ is $var\left(f^* \mid \mathbb{A}\right)^{-1} cov(f^*, R \mid \mathbb{A}) = cov(\tilde{f}, R \mid \mathbb{A})$.

4.2 Real versus Nominal Rates

We have constructed our two policy shocks based on the changes in nominal yields. This can be decomposed into inflation expectations, the expected path of real rates and the risk premium. In this section, we seek to further characterize our factors by estimating their covariance with these components. In particular, we are interested in whether the changes in long-term rates from the policy shock are about long-term inflation forecasts or long-term real rates. Policy shocks that affect inflation expectations only impact nominal but not real yields whereas policy shocks that change long-term real rates will have non-zero covariance with both nominal and real yields.

Beginning in 1999, Treasury-Inflation Protected Securities (TIPS) provide a measure of yields absent expectations of future inflation. We obtain zero coupon TIPS yields constructed according to the Gürkaynak et al. (2010) methodology, which interpolates a discount curve from closing market bid yields on actively traded TIPS securities in the over-the-counter secondary market. We focus on yields with maturities between 5 and 10 years as TIPS have historically been issued at 5, 7, and 10 year maturities. If the movement in nominal yields is primarily caused by changes in inflation expectations, we expect covariance with real rates to be close to zero. However, if the path of real rates or the risk premium are important, then real rates should be further from zero than the corresponding nominal rate.

Figure 9 summarizes the covariance of the factors with nominal and real yields. Similar to the principal component weights, the confidence factor affects the entire yield curve, absent the short rate. In the 5-10 year maturity range, the covariance of the confidence factor with real rates is greater than the covariance with nominal rates; hence the first factor is not associated with meaningful changes in inflation expectations. The monetary policy factor is characterized by a strong covariance with changes in the Fed Funds rate and a negative covariance with long-term nominal rates. However, long-maturity real rates are close to zero, suggesting that at the second factor has little impact on real rates at the long end of the yield curve but does lower inflation expectations.[8]

We can estimate the statistical significance of these differences using the regression specification summarized in Equation (9). The interaction between the factors and announcements days reveal the covariance between yields and the policy factors. Table 1 reports the estimated coefficients, together with Newey-West t-statistics. We consider five- and ten-year nominal yields (Columns 1 and 2) and breakeven rates (Columns 3 and 4). Breakeven rates, calculated as the difference between nominal and real yields of the same maturity, measure risk-neutral inflation expectations. Consistent with the figure, the confidence factor positively covaries with nominal yields at both maturities and the difference is statistically significant at the 1% level. However, there is no discernible relation with breakevens in Columns 3 and 4, which suggests that the confidence factor impacts real yields. Changes in long-term real yields can come from changes in expected future real interest rates or changes in risk premium. If the observed changes are about expected future real rates, the confidence shock has a very long-lasting effect on the economy, which can only be reconciled with the explanation of a long-run change in perception of policy rules. If the observed changes are about risk premium, this is more consistent with the Federal Reserve affecting perceptions of uncertainty or risk appetite in the economy, not necessarily for the long-run. The fact that the market confidence shock has similar impact on both five- and ten-year nominal yields makes the risk premium channel a more plausible explanation.

Unlike the confidence factor, the covariance of the monetary policy factor with longer maturities is difficult to distinguish from a change in inflation expectations. The mone-

[8] See Figure 5 for estimates of the covariance with nominal yields for the full sample periods.

tary policy factor is negatively related with nominal yields and this relation is larger and more significant at the longer maturity (Column 4). The covariance with breakevens is of similar magnitude to those of nominal yields: a one standard deviation increase in the traditional monetary policy shock decreases the five year nominal yield by 1.3 bps and the five year real yield by 1.8 bps; however, the difference from non-announcement covariances is not statistically significant at standard levels (the p-values are approximately 14%). A negative relationship between breakevens and short rates is consistent with a classic inverse relationship between Fed Funds shocks and long-term inflation expectations.

4.3 Stock Returns

We now turn to the relation of our policy factors with stock returns. This analysis helps characterize the impact of FOMC announcements beyond the Treasury market, and provides additional evidence on the hypothesis that the confidence shock affects risk premia.

We estimate Equation (9) via OLS using the excess market return as the dependent variable.[9] Column 1 of Table 2 summarizes our findings. We find that the confidence factor is negatively correlated with market returns at the 5% significance level. A one standard deviation increase in the market confidence factor decreases stock returns by 50bps, consistent with an increase in expected future returns. Thus, long rates on announcements days behave in a manner consistent with changing uncertainty which impacts the risk premium for both fixed income (as reflected in yields on both nominal and real Treasury securities) and equity instruments. In contrast, on non-announcement days the long-term rates are *positively* correlated with market returns – emphasizing that monetary policy announcements create a unique risk in equities. The monetary policy factor is also negatively associated with the

[9] We use the CRSP value-weighted market return.

market return, but the coefficient is not statistically significant.[10]

In addition to impacting the aggregate returns, policy announcements may also have heterogenous effects across firms. To test this redistributive effect, we consider the correlation between HML and SMB portfolio returns and the two policy shocks. The HML portfolio measures the performance of value (high book-to-market, H) stocks relative to growth (low book-to-market, L) stocks, while the SMB portfolio measures the performance of small (S) stocks relative to large (B) stocks. These two factors are known to be important in pricing the cross-section of equity returns (see Fama and French, 1993, and the subsequent literature). Columns 2 and 3 of Table 2 report the results estimating (9) using HML and SMB returns as the dependent variables, respectively. We find that while neither shock is related in a statistically significant manner to SMB returns, the monetary policy shock is significantly positively related to the return on HML on announcement days. That is, a one standard deviation unexpected increase in the Fed funds rate decreases the value premium by 43 bps. This is consistent with the monetary policy target rate having redistributive effects in the economy.

In Appendix Figure A4, we plot the differential covariance between the two policy factors on announcement days for the 25 equity portfolios sorted by size and book-to-market (FF25). Panel (a) shows that, consistent with the confidence shock impacting the aggregate risk premium, the covariance of the first policy factor on FOMC announcement days with the FF25 portfolio returns is uniformly higher than that on non-announcement days. In contrast, the monetary policy shock has an increase in correlation with the five value portfolios and

[10] In contrast, Bernanke and Kuttner (2005) find that the Fed funds shock estimated from changes to the front month Fed funds futures contract around announcement days is significantly, positively related to aggregate market risk premia. Our results show, however, that appropriately controlling for non-policy variance and including the long-rate policy factor attenuates the statistical significance of the short-term factor in explaining aggregate market returns.

a decrease in correlation with the five growth portfolios (Panel (b)), generating the positive differential covariance with the HML return we saw in Table 2.[11]

4.4 Aggregate Uncertainty

One mechanism by which FOMC announcements might affect market confidence is by shifting beliefs about aggregate uncertainty. We investigate whether the factors correlate with uncertainty in a way that is consistent with our findings on the risk premium in equity markets.

Columns 4-7 of Table 2 test this mechanism by estimating Equation 9 via OLS using different measures of changes to aggregate volatility as the dependent variable: one month options-implied volatility of S&P 500 returns (VIX, Column 4), one month options-implied volatility of S&P 100 returns (VXO, Column 5), one month options-implied volatility of interest rate swaps (SMOVE, Column 6), and the Baker et al. (2013) index of political uncertainty (Column 7). For all these measures, we find that the confidence shock is positively correlated with announcement-day changes. The differences are both economically and statistically significant for the VIX, VXO, and SMOVE: a one standard deviation increase in the confidence shock increases implied stock market volatility by 2.7 percent (2.9 percent for S&P 100) and implied swap rate volatility by 1.8 percent. Thus, the confidence shock leads to increases in aggregate uncertainty on announcement days. The monetary policy shock is negatively associated with changes in volatility, but the coefficient is not statistically significant.

In sum, we find that the market confidence factor is correlated with measures of the risk premium and uncertainty whereas the second factor is linked to short-term rates and

[11] Ozdagli (2014) and Ozdagli and Weber (2016) analyze further properties of firms shaping the cross-sectional response of stock returns to standard monetary policy shocks.

inflation expectations. The characterization of the first factor introduces a unique role for policy announcements. Time variation in uncertainty and the risk premium can act as a form of policy transmission as they affect investment choices (see e.g. Lucas and Prescott, 1971; Bloom et al., 2007; Bloom, 2009) and the value of household portfolios (i.e. the "wealth effect") (see e.g. Sandmo, 1970; Grossman and Zhou, 1996; Basak, 1995).

4.5 Other Risky Assets

We finally measure the response of other asset prices often associated to the conduct of monetary policy. Column 1 of Table 3 estimates Equation (9) via OLS using the two day change in the trade-weighted U. S. dollar exchange rate relative to a basket of major currencies as the dependent variable.[12] We find that the confidence factor is positively correlated with the exchange rate at the 1% significance level. In other words, the U. S. dollar appreciates against other currencies by 29 bps when long rates increases and confidence drop, consistent with the safe-haven currency status of the U. S. dollar.

Columns (2)–(4) of Table 3 estimates Equation (9) via OLS using the returns on the S&P GSCI overall, energy and non-energy spot commodity indices as the dependent variable, respectively.[13] Consistent with the results for aggregate uncertainty and market returns, we find that the confidence factor is negatively correlated with commodity returns at the 5-10% significance level, with a one standard deviation increase corresponding to a 72 bps

[12]The trade-weighted U. S. dollar exchange rate is a weighted average of the foreign exchange value of the U. S. dollar against a subset of the broad index currencies that circulate widely outside the country of issue. The major currencies index includes the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. The index is higher when the U. S. dollar appreciates relative to other currencies.

[13]The S&P GSCI spot index is a world production-weighted average of prices on liquid commodity futures contracts. The spot index is built to be the equivalent of the S&P 500 equity index for commodities. The overall index consists of 24 futures on physical commodities across five sectors: energy, agriculture, livestock, industrial metals and precious metals. The non-energy subindex includes all futures not included in the energy subindex.

decrease in the broad index, 100 bps decrease in the energy subindex and a 29 bps decrease in the non-energy subindex. In contrast, on non-announcement days, the confidence factor is positively, but not statistically significantly, correlated with commodity returns, highlighting once again that FOMC announcements create a unique source of risk for many assets. The monetary policy factor is positively correlated with commodity returns on announcement days, but the correlation is statistically significant only for the non-energy subindex. That is, an unexpected increase in the Fed funds rate yields favorable returns to investors in non-energy commodities. A potential explanation may be the signaling effect proposed by Romer and Romer (2004), with market participants interpreting an unexpected increase in the policy rate as a signal for the strength of the economy.

5 Impact of Announcement Shocks on Credit Market Conditions

In this section we present a methodology for considering the role of our shocks on lower frequency variables. We then use this method to consider the impact of our announcement shocks on credit market conditions.

5.1 Measuring the Covariance of Shocks with Low Frequency Variables

We now extend the methodology of Section 4 to allow the affected variable to be measured at a lower frequency than monetary policy shocks. Suppose that we observe real outcomes m_t every τ days so that we can only construct τ-day changes ($\tau = 7$ in our applications on weekly data)

$$\Delta_\tau m_t \equiv m_t - m_{t-\tau} = \sum_{s=0}^{\tau-1} \Delta m_{t-s},$$

where we use Δm_t to denote one-day changes. If we were able to observe the one-day changes directly, similarly to the financial variables in section 4, we would represent Δm_t as the sum of a non-announcement and a policy component

$$\text{Non-announcement: } \Delta m_t = \xi_{m,t}$$
$$\text{Announcement: } \Delta m_t = \xi_{m,t} + \beta_{1,m} f_{1,t} + \beta_{2,m} f_{2,t}.$$

We maintain the assumption that the non-policy component is independent of the policy factors but can covary with the non-policy component of nominal yields, so that $\text{cov}(\xi_{m,t}, \nu_t) \neq 0$. The τ day change can thus be represented as

$$\Delta_\tau m_t = \sum_{s=0}^{\tau-1} \left(\xi_{m,t-s} + \beta_{1,m} f_{1,t-s} \mathbb{A}_{t-s} + \beta_{2,m} f_{2,t-s} \mathbb{A}_{t-s}\right).$$

We also construct the low frequency version of the contaminated policy shocks. Using the same expansion of τ-day changes of yields into one-day yield changes, we can define the low frequency contaminated shocks as

$$\tilde{f}_{i,t}^{\tau} = \sum_n \omega_i^{(n)} \Delta_\tau y_t^{(n)} = \sum_{s=0}^{\tau-1} \left(f_{i,t-s} \mathbb{A}_{t-s} + \sum_n \omega_i^{(n)} \nu_{t-s}^{(n)} \right). \tag{11}$$

The covariance between the low frequency variable and the observed factor j is given by

$$\text{cov}\left(\Delta_{\tau}m_t, \tilde{f}_{j,t}^{\tau}\right) = \text{cov}\left(\sum_{s=0}^{\tau-1}\xi_{m,t-s}, \sum_{s=0,n}^{\tau-1}\omega_j^{(n)}\nu_{t-s}^{(n)}\right) + \beta_{j,m}\text{var}\left(\sum_{s=0}^{\tau-1}f_{j,t-s}\mathbb{A}_{t-s}\right),$$

where we have allowed the policy factors to be serially correlated. Assuming the covariance between non-policy shocks is stable over time, we can derive the impact of policy shocks by differencing between estimates for periods containing different number of announcement days.

As with the returns, we operationalize estimating the covariance differences by estimating the differential response of real activity on periods with different numbers of announcements:

$$\Delta_{\tau}m_t = \alpha_{0,m} + \alpha_{1,m}\mathbb{N}_{t,\tau} + \gamma_{1,m}f_{1,t}^{\tau*} + \gamma_{2,m}f_{2,t}^{\tau*} + \beta_{1,m}^{l}\left(f_{1,t}^{\tau*}\mathbb{N}_{t,\tau}\right) + \beta_{2,m}\left(f_{2,t}^{\tau*}\mathbb{N}_{t,\tau}\right) + \varepsilon_{m,t}, \quad (12)$$

where $\mathbb{N}$ is the count variable of the number of announcements between $t-\tau$ and t, and $f_{1,t}^{\tau*}$ and $f_{2,t}^{\tau*}$ are scaled using a similar procedure as equation (10) . In our analysis below, we also sometimes include lags of both the policy factors and the dependent variable in the specification to capture the potential lagged response of real activity to monetary policy shocks.

Appendix Table A1 estimates Equation (12) the covariance between Treasury yields and the policy factors using one week changes in yields. While we loose some statistical significance of the estimates, the results are broadly similar to those of Table 1 (which uses the baseline two-day changes to identify the covariance). This suggests that the procedure described above performs reasonably well at a weekly frequency.

5.2 Results

Tables 2-3 show that the confidence factor is negatively correlated with measures of market confidence on announcement days for fixed income, equity, exchange rate and commodity markets. We now investigate whether this variation affects credit markets. The confidence shock should decrease both credit demand and credit supply and, thus, in equilibrium, the overall quantity of credit. The equilibrium impact on the pricing of credit is, however, ambiguous and is determined by whether the demand effect or the supply effect dominates.

Table 4 summarizes estimates of Equation (12) via OLS using measures of credit conditions as the dependent variable. Columns (1)-(4) test the impact of announcement shocks on measures of corporate credit conditions. The confidence factor is positively correlated with changes to the commercial paper rate paid by AA-rated non-financial issuers (Column 1), the commercial paper rate paid by AA-rated financial issuers (Column 2) and the yield on the Bank of America (Merrill Lynch) index of U. S. high yield bonds.[14] On announcement days, the confidence factor is even more positively correlated with these three measures of corporate borrowing costs, consistent with the depreciation in response to a confidence shock experienced by the other risky asset classes above: a one standard deviation change in the confidence factor increases the commercial paper rate paid by AA-rated non-financial and financial issuers by 7 and 6.5 basis points, respectively. That is, the commercial paper rate reacts more than one-for-one to the change in the confidence factor.[15]

The monetary policy shock is also positively correlated with commercial paper interest

[14]The Bank of America (Merrill Lynch) U. S. High Yield Master II index includes U. S. dollar denominated corporate debt issued in the U. S. domestic market with credit rating below investment grade. The securities must have more than one year of remaining maturity, a fixed coupon schedule and a minimum outstanding amount of $100 million.

[15]Recall that the five year rate increases by 5 basis points in response to a one standard deviation change in the confidence factor.

rates and the yield on high yield bonds. That is, an unexpected increase to the policy rate tightens credit conditions. Indeed, financial conditions as measured by the Chicago Fed National Financial Conditions Index (NFCI) tighten one week after a traditional policy, and continue to tightening the following week, with a one standard deviation in the factor increasing NFCI by 65 bps in the first week and by a further 50 bps in the second week.[16] In contrast, in other weeks, changes to the NFCI are not statistically significantly correlated with the short rate factor.

Turning to credit conditions for the household sector, Column 5 shows that the Freddie Mac 30-year fixed rate mortgage interest (FRM) rate increases in response to both policy shocks, with a one standard deviation in the traditional policy shock increasing the FRM rate by 2.5 bps in the first week after the announcement and a one standard deviation in the confidence shock increasing the FRM rate by 4 bps in the second week after the announcement.[17] Columns 6-9 measure the impact of monetary policy shocks on the number of mortgage applications for purchases, refinancing, fixed rate and adjustable rate mortgages, respectively.[18] Mortgage applications respond sluggishly to announcements, with both the confidence factor and the traditional monetary policy factor only having a significant impact two weeks after the announcement. Though both applications for mortgages for new purchases and applications for mortgage refinancing decline in response to the traditional monetary policy factor, the response of refinancing is significantly larger: a one standard

[16]The Chicago Fed National Financial Conditions Index (NFCI) is the first principal component of price and volume measures of financial activity, covering money markets, debt and equity markets, as well as both the traditional and the shadow banking system. The values of the index are standardized; positive values indicate a tightening in financial conditions relative to historical averages.

[17]The mortgage rates are based on an average of a survey of lenders conducted by Freddie Mac. The survey is conducted weekly, typically prior to the FOMC announcement.

[18]Mortgage application data is from the weekly mortgage applications survey conducted by the Mortgage Bankers Association. The survey covers roughly 50% of all U. S. residential mortgage applications processed by mortgage banks, commercial banks and thrifts.

deviation increase in the shock decreases applications for mortgages for new purchases by 7 percent, while applications for mortgages for refinance purposes declines by nearly 19 percent. Applications for mortgage refinancing are also more responsive to the confidence shock, with a one standard deviation increase in the confidence shock decreasing applications for mortgage refinancing by 13 percent while the applications for mortgages for new purchases decrease by 5 percent. The fact that refinancing demand is more elastic with respect to monetary policy is consistent with the findings in Beraja et al. (2015) on the refinance channel of monetary policy.

6 Conclusion

In this paper, we demonstrate that FOMC announcements impact the prices of risky assets via two distinct channels: a standard monetary policy shock, and a novel market confidence shock. While there is a clear understanding of how the Fed can manipulate short rates, it less clear how it impacts market confidence. We cannot precisely identify how the Fed does this, but we can demonstrate that there is an impact and there are wide-ranging implications for a host of financial conditions. It may be that policy statements reveal information about the state of the economy or the future behavior of monetary policy, thereby impacting aggregate uncertainty and the risk premium. But, it is not clear that these actions are purposeful. It may be the variation in long rates is an unintended consequence of communication.

Regardless, our findings suggest that central bankers should consider their impact on long rates and risk premia as separate from conventional monetary tools. The recent experience of monetary policy at the zero lower bound has reignited the debate on the efficacy of monetary policy to impact real outcomes. Our results suggest that monetary policy can have an impact

– even at the zero lower bound – by acting through risk premia. A positive innovation to the confidence shock increases aggregate uncertainty, increasing the risk compensation demanded by investors in both bond and equity markets. This channel is distinct from the effects of unconventional monetary policy, as it is present even before the start of the financial crisis in 2007. As the U.S. exits the zero lower bound, it is crucial to revisit the potential role of monetary policy at both the short- and long-end of the yield curve.

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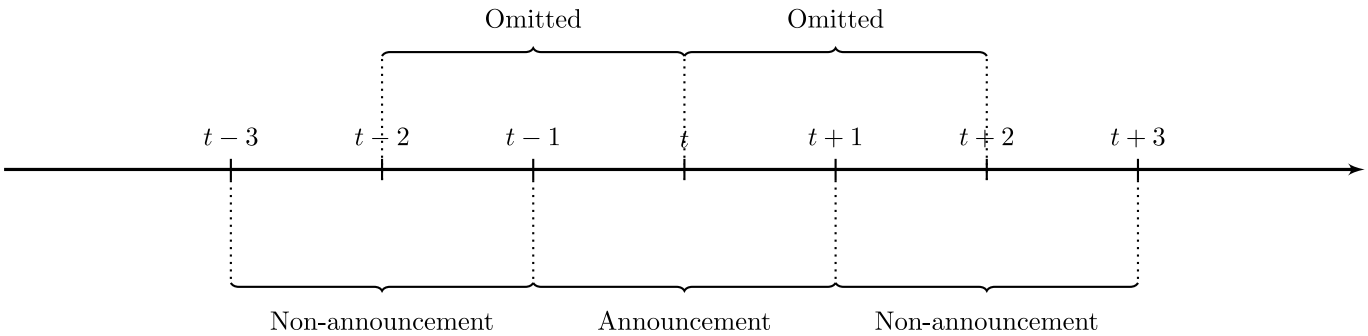
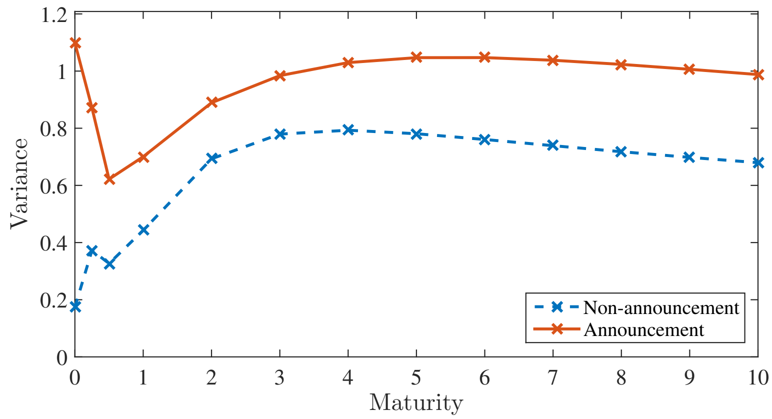
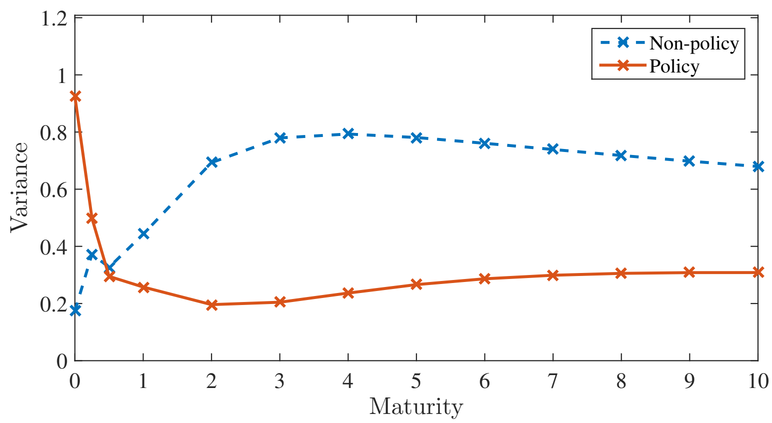


Figure 1: Stylized timeline of shock identification



(a) Announcement vs. Non-Announcement



(b) Policy vs. Non-Policy

Figure 2: Comparing variances in the yield curve

Figure 2 illustrates the variance in yield changes at a range of maturities. Maturities are in years where the zero maturity yield is the change in the front month Fed Funds future. The sample period runs from 1994-2007 and includes 113 FOMC announcement days. Figure 2(a) compares FOMC announcements days versus non-announcement days. Figure 2(b) compares policy variance (announcement less non-announcement) and non-policy variance (announcement variance).

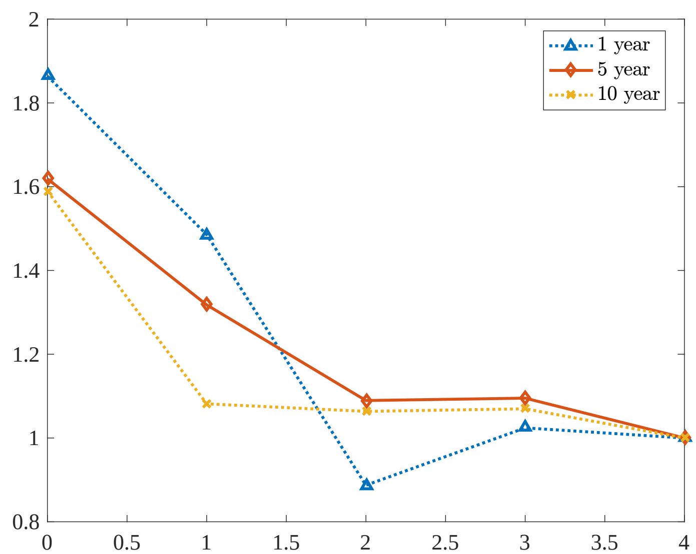


Figure 3: Variance of one-day changes to the yield curve

Figure 3 illustrates the variance of the daily change to the yields of different maturities following an FOMC announcement (date 0). Maturities are in years where the zero maturity yield is the change in the front month Fed Funds future. The sample period runs from 1994-2007 and includes 113 FOMC announcement days. Variances rescaled to be equal to 1 on day 4 for comparison purposes.

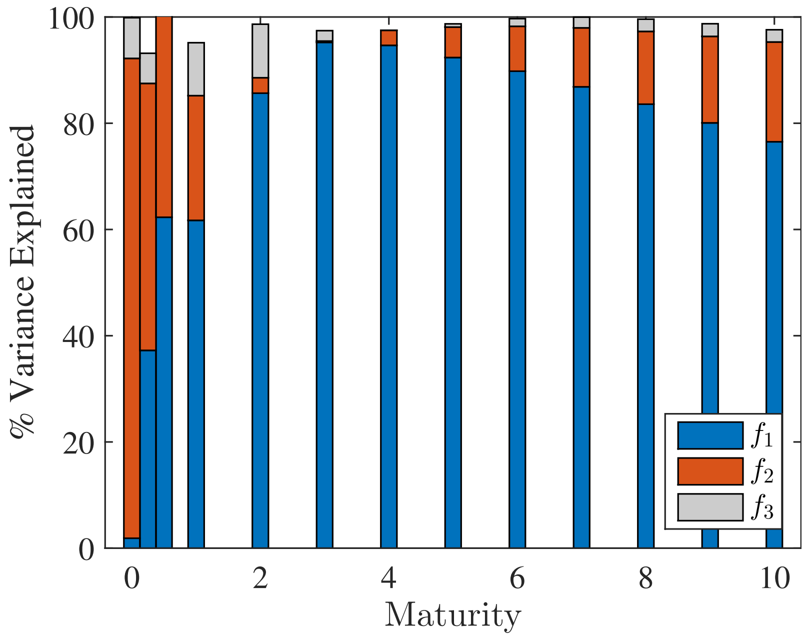


Figure 4: Fraction of explained policy variance by first three principal components

Figure 4 illustrates the policy variance attributable to the first three principal components of the policy matrix at various maturities ranging from the forward Fed Funds rate to 10 years.

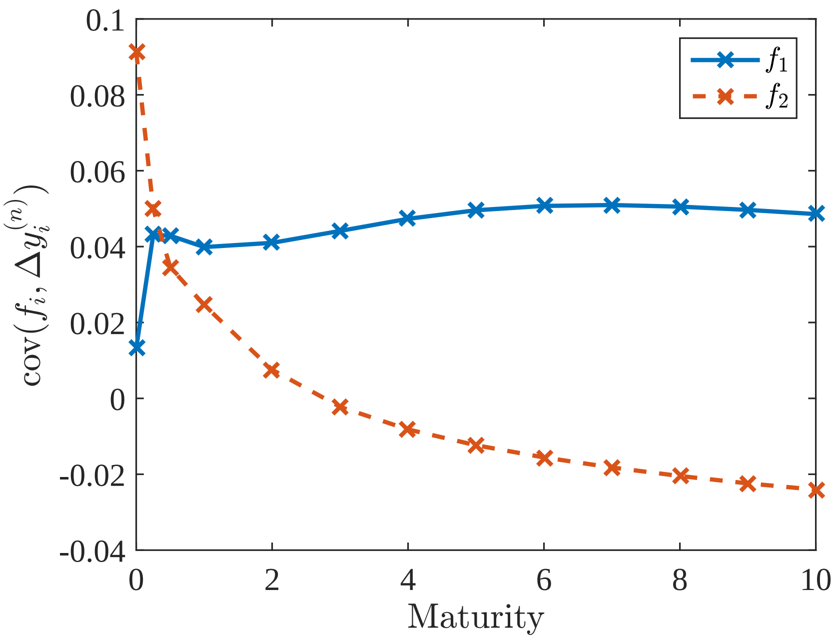
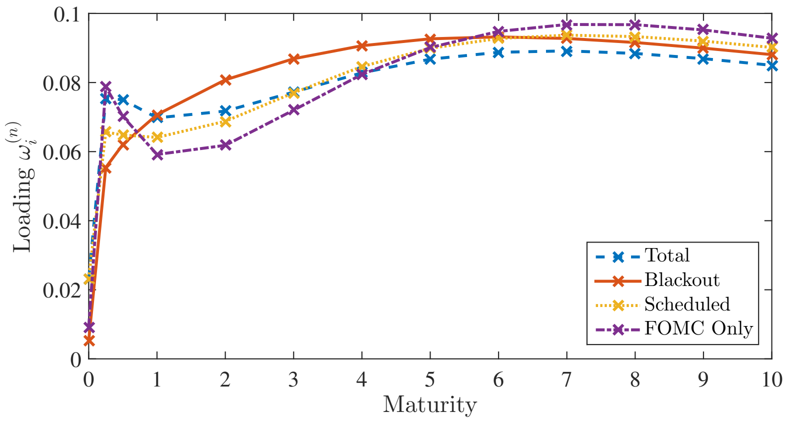
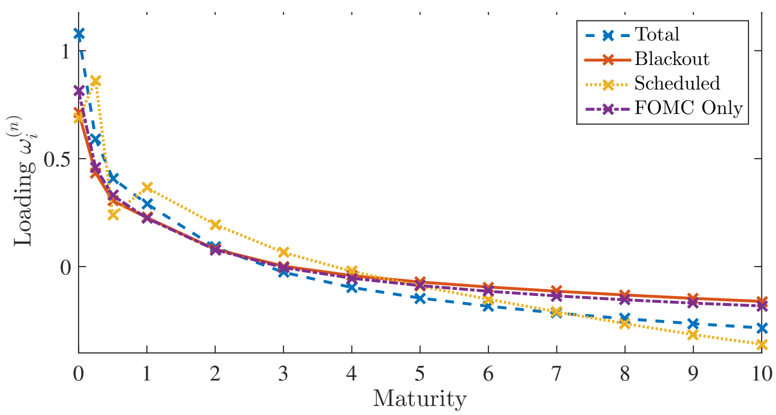


Figure 5: Covariance of yields and policy factors: 1994-2007

Figure 5 illustrates the covariance of the two policy factors with changes in yields. Maturities are in years where the forward Fed Funds rate is 0.



(a) f_1



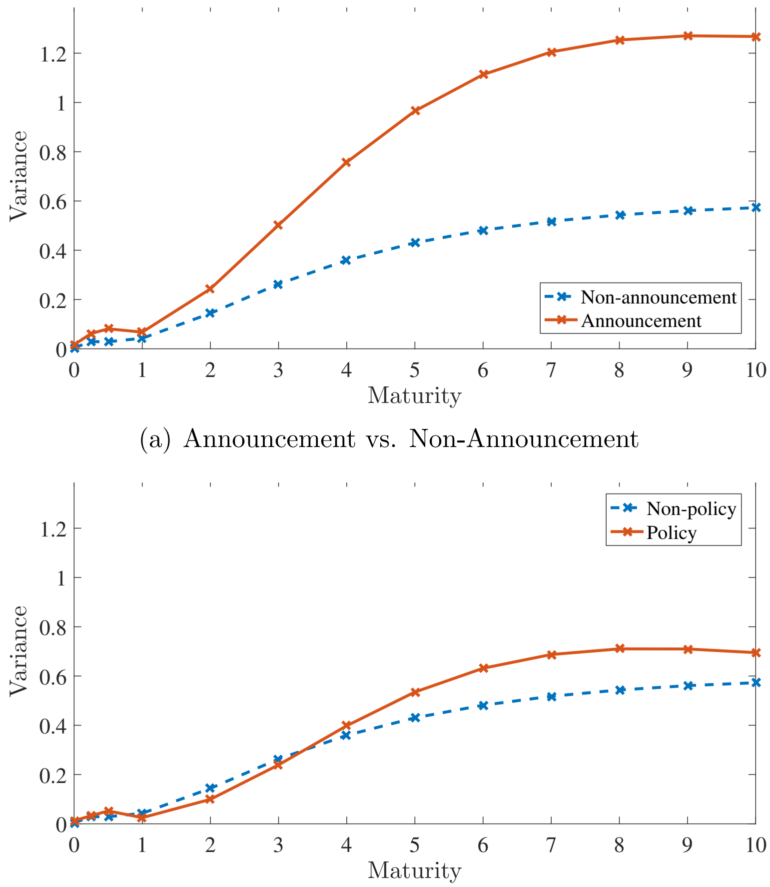
(b) f_2

Figure 6: Comparing principal component loadings across samples

Figure 6 illustrates the loadings on yields of various maturity for the first two principal components of the policy variance matrix.

$$f_{i,t} = \sum_n \omega_i^{(n)} \Delta y_t^{(n)}$$

Loadings in this figure are weighted such that they sum to one. Maturities are in years where the forward Fed Funds rate is 0. Components are derived from three different estimates of the policy covariance matrix. *Total* is the base specification that compares all announcement days vs. all non-announcement days. *Blackout* compares all announcement days to days in the FOMC blackout period. *Scheduled* compares scheduled announcement days to all non-announcement days. Figure 6(a) displays the weights for the first component and Figure 6(b) for the second.



(a) Announcement vs. Non-Announcement

(b) Policy vs. Non-Policy

Figure 7: Comparing variances in the yield curve: 2010-2016

Figure 7 illustrates the variance in yield changes at a range of maturities. Maturities are in years where the zero maturity yield is the change in the front month Fed Funds future. The sample period runs from 2010-2016 and includes 56 FOMC announcement days. Figure 7(a) compares FOMC announcements days versus non-announcement days. Figure 7(b) compares policy variance (announcement less non-announcement) and non-policy variance (announcement variance).

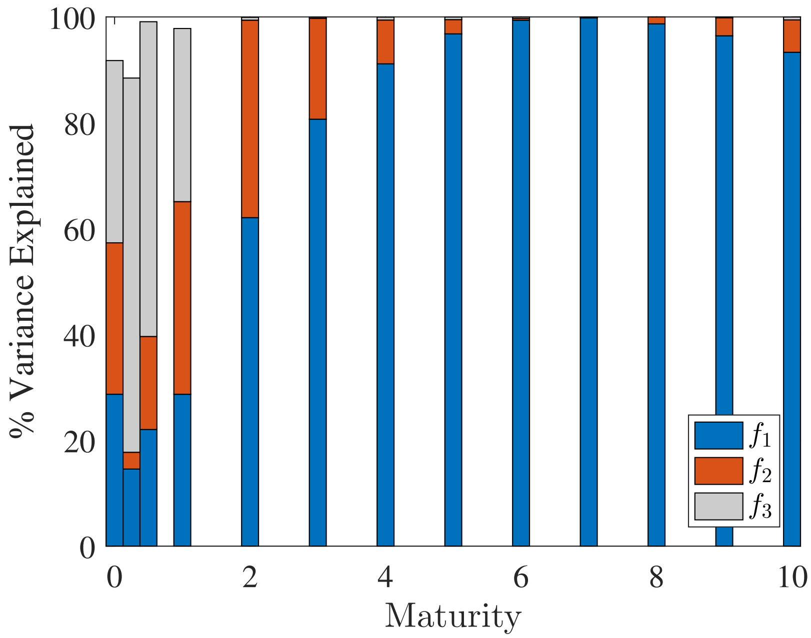


Figure 8: Fraction of explained policy variance by first three principal components: 2010-2016

Figure 8 illustrates the policy variance attributable to the first three principal components of the policy matrix at various maturities ranging from the forward Fed Funds rate to 10 years.

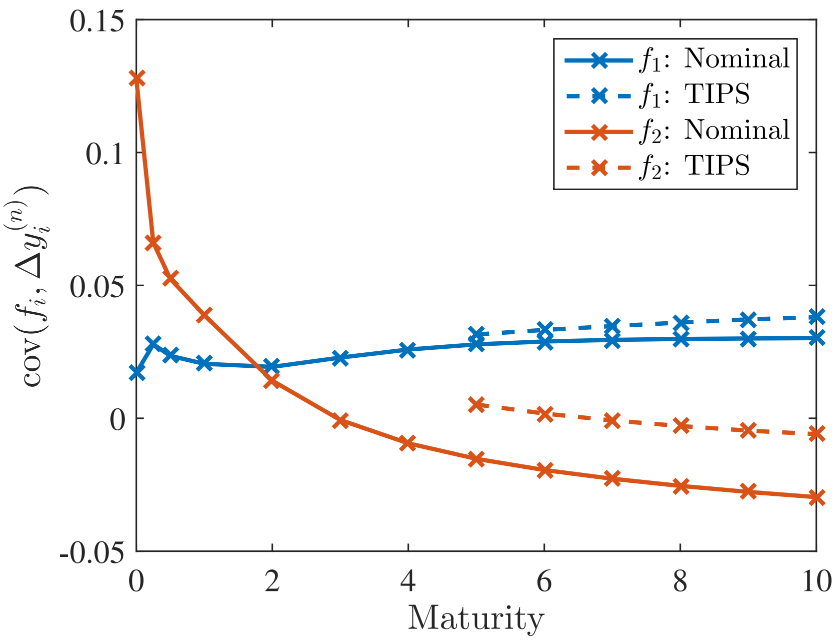


Figure 9: Covariance of yields and policy factors: 1999-2007

Figure 9 illustrates the covariance of the policy factors with changes in yields. Maturities are in years where the forward Fed Funds rate is 0.

Table 1: Covariance of yields and breakevens with policy factors

Dep. Var.	(1) 5 year	(2) 10 year	(3) 5 yr BE	(4) 10 yr BE
A	0.45***	-0.58**	-1.08	-1.24
	(0.13)	(0.27)	(0.68)	(0.80)
f_1	13.90***	12.24***	6.44***	5.22***
	(0.05)	(0.11)	(0.41)	(0.27)
f_2	-3.21***	-3.44***	-2.04***	-2.03***
	(0.04)	(0.11)	(0.16)	(0.15)
f_1A	5.09***	5.21***	0.04	-1.18
	(0.31)	(0.73)	(1.53)	(2.22)
f_2A	-1.29**	-2.26***	-1.76	-1.92
	(0.51)	(0.28)	(1.08)	(1.29)
Observations	1996	1996	1996	1996
R-squared	0.99	0.95	0.32	0.32

Table 1 contains coefficient estimates from a regression of changes in Treasury yields (in bps) on changes in our policy factors. The interaction terms reveal the covariance between monetary policy announcements and the dependent variable. In Columns 1 and 2 the dependent variable is the nominal yield on the five- and ten-year constant maturity Treasury, respectively. In Columns 3 and 4 the dependent variable is the breakeven yield at the five- and ten-year maturity, respectively. The sample period is from 1999-2007. Standard errors in parentheses are calculated over time using Newey-West (5 lags); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Covariance of equity factors and volatility measures with policy factors

Dep. Var.	(1) $R_M - r_f$	(2) R_{HML}	(3) R_{SMB}	(4) Δvix	(5) Δvxo	(6) $\Delta smove$	(7) Δepu
A	0.33**	-0.10	0.03	-3.93***	-2.40***	-1.17**	-49.67***
	(0.14)	(0.09)	(0.09)	(0.80)	(0.82)	(0.52)	(11.55)
f_1	0.23***	-0.11***	0.17***	-0.53	-0.89**	1.38***	-4.97
	(0.08)	(0.03)	(0.04)	(0.36)	(0.38)	(0.30)	(3.36)
f_2	0.00	0.01	-0.04**	0.05	-0.10	-0.78***	3.86***
	(0.02)	(0.01)	(0.02)	(0.11)	(0.12)	(0.11)	(1.29)
f_1A	-0.55**	-0.03	-0.19	2.70	2.92*	1.83**	26.86
	(0.28)	(0.16)	(0.18)	(1.74)	(1.76)	(0.92)	(19.87)
f_2A	-0.05	0.43**	0.03	0.52	1.15	0.82	-15.20*
	(0.45)	(0.20)	(0.13)	(0.70)	(0.82)	(1.10)	(8.96)
Observations	3148	3148	3148	3141	3137	3103	3154
R-squared	0.01	0.02	0.01	0.01	0.01	0.06	0.01

Table 2 contains coefficient estimates from a regression of equity returns (in percent) and changes in volatility measures on changes in our policy factors. The interaction terms reveal the covariance between monetary policy announcements and the dependent variable. In Columns 1, 2, and 3 the dependent variable is the excess return on the market, the return on the HML, and the return on SMB, respectively. Column 4 is the change in logs of the VIX, Column 5 is the change in logs of the VXO, Column 6 is the change in logs of the one-year SMOVE, and Column 7 is the change in the economic policy uncertainty from Baker et al. (2013). Log changes are multiplied by 100. The sample period is from 1994-2007. Standard errors in parentheses are calculated over time using Newey-West (5 lags); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Covariance of risky asset returns with policy factors

Dep. Var.	(1) Trade-weighted EX	(2) Commodity Index	(3) Energy Index	(4) Non-Energy Index
A	-0.02	-0.14	-0.26	0.00
	(0.05)	(0.18)	(0.27)	(0.09)
f_1	0.10***	0.07	0.01	0.17***
	(0.02)	(0.07)	(0.12)	(0.03)
f_2	0.00	-0.07**	-0.08	-0.05***
	(0.01)	(0.03)	(0.05)	(0.01)
f_1A	0.28***	-0.72**	-1.00*	-0.28*
	(0.09)	(0.34)	(0.53)	(0.15)
f_2A	-0.02	0.31	0.38	0.15*
	(0.05)	(0.30)	(0.43)	(0.08)
Observations	3152	3151	3149	3151
R-squared	0.02	0.01	0.00	0.01

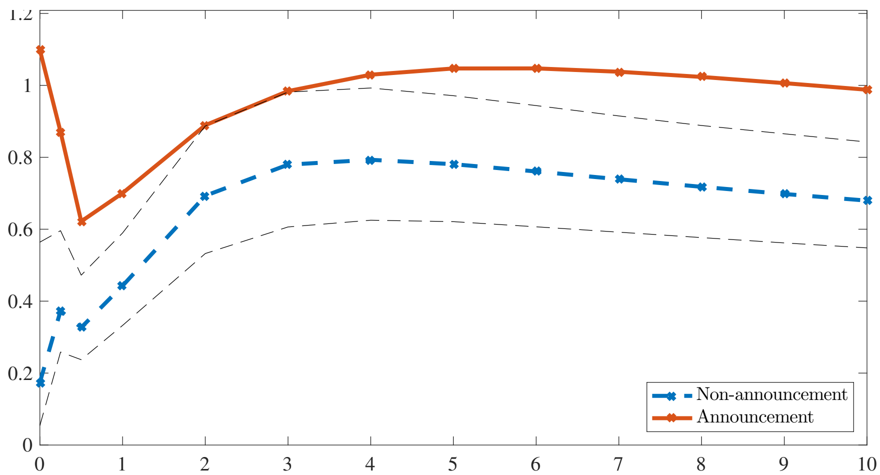
Table 3 contains coefficient estimates from a regression of returns on other risky assets on changes in our policy factors. The interaction terms reveal the covariance between monetary policy announcements and the dependent variable. In Column 1, the dependent variable is the percentage change to the trade-weighted U.S. exchange rate to major currencies. In Columns 2-4, the dependent variable is the percentage change to the S&P GSCI spot index for all commodities, energy commodities, and non-energy commodities, respectively. The sample period is from 1994-2007. Standard errors in parentheses are calculated over time using Newey-West (5 lags); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Covariance of credit condition measures with policy factors

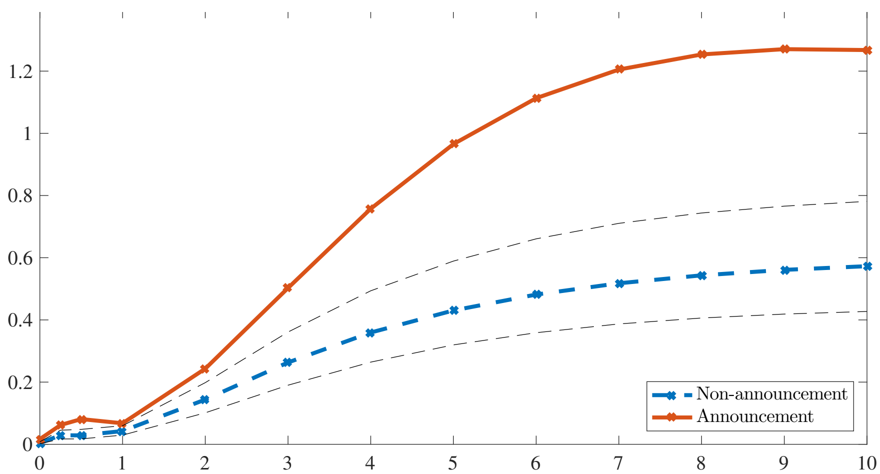
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Corporate credit conditions					Household credit conditions			
Dep.Var.	AA CP rate (Non.-fin.)	AA CP rate (Fin.)	HY yield	NFCI	FRM rate	Purchases	Refinance	FRM	ARM
A	0.56	1.01**	0.95						
	(0.63)	(0.45)	(0.97)						
f_1	1.41***	1.64***	1.98***						
	(0.20)	(0.16)	(0.47)						
f_2	0.15	0.16*	-0.57***						
	(0.10)	(0.10)	(0.19)						
f_1A	2.89**	3.54***	2.72						
	(1.29)	(1.12)	(1.73)						
f_2A	7.25***	6.43***	0.42						
	(0.91)	(0.82)	(1.41)						
$L.$A				-0.01	0.01	-2.92***	-2.39	-2.59**	-1.81
				(0.11)	(0.87)	(1.08)	(1.54)	(1.23)	(1.34)
$L.f_1$				0.01	11.00***	-3.06**	-13.36***	-9.16***	-1.28
				(0.14)	(1.06)	(1.50)	(2.58)	(2.00)	(1.84)
$L.f_2$				-0.04	-2.52***	-0.20	1.87*	1.21	-0.73
				(0.05)	(0.34)	(0.69)	(1.00)	(0.85)	(0.97)
$L.f_1$A				0.36	0.89	3.42	1.50	1.27	3.08
				(0.32)	(2.03)	(3.95)	(5.86)	(4.81)	(4.01)
$L.f_2$A				0.65**	2.52**	2.31	-4.07	-1.12	0.69
				(0.29)	(1.06)	(2.06)	(4.52)	(3.16)	(2.15)
$L2.$A				-0.17	1.29	-11.14***	-11.07***	-10.60***	-11.36***
				(0.14)	(0.90)	(1.55)	(2.14)	(1.78)	(1.81)
$L2.f_1$				0.09	1.21	-1.32	-13.72***	-7.87***	-3.83***
				(0.12)	(0.91)	(1.30)	(2.11)	(1.62)	(1.49)
$L2.f_2$				-0.08	-0.76**	-0.12	3.99***	2.18***	0.18
				(0.07)	(0.30)	(0.60)	(1.06)	(0.80)	(0.68)
$L2.f_1$A				-0.14	4.19*	-5.32	-12.93*	-8.68*	-7.57
				(0.39)	(2.47)	(3.70)	(6.67)	(4.66)	(4.98)
$L2.f_2$A				0.50***	-0.91	-7.19***	-18.69***	-13.17***	-13.91**
				(0.16)	(1.23)	(2.75)	(5.96)	(4.24)	(5.57)
Observations	1712	2457	3156	706	706	706	706	706	706
R-squared	0.17	0.19	0.03	0.63	0.23	0.19	0.21	0.19	0.19

Table 4 contains coefficient estimates from a regression of changes to measures of credit conditions on changes in our policy factors. The interaction terms reveal the covariance between monetary policy announcements and the dependent variable at different lags. Columns 1-5 measure credit conditions for the corporate sector. In Columns 1, 2, and 3, the dependent variables is the two-day change of the AA CP rate for non-financial borrowers, the two-day change of the AA CP rate for financial borrowers, and the two-day change of the average yield of a basket of high yield-rated bonds, respectively, expressed in bps. Column 4 is the weekly change in the Chicago Fed's National Financial Conditions Index, scaled by 100. Columns 5-9 measure credit conditions for the household sector. In Column 5, the dependent variable is the weekly change to the average fixed rate mortgage rate, expressed in bps. In Columns 6-9, the dependent variable is the weekly percentage change to the number of mortgage applications for purchases, refinances, fixed rate mortgages and adjustable rate mortgages, respectively. The sample period is from 1994-2007. Regressions in Columns 4 and 6-9 include three lags of the dependent variable. Standard errors in parentheses are calculated over time using Newey-West (5 lags); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A Additional Results



(a) 1994-2007



(b) 2010-2016

Figure A1: Comparing variances in the yield curve: Placebo

Figure A1 illustrates the variance in yield changes at a range of maturities. Maturities are in years where the zero maturity yield is the change in the front month Fed Funds future. The sample period runs from 1994-2007 and includes 113 FOMC announcement days for Panel (a) and from 2010-2016 and includes 56 FOMC announcement days for Panel (b). The figure compares the variance of changes in yields onFOMC announcements days versus non-announcement days. The dashed black lines represent the 10th and 90th percentiles of variances obtained by randomizing announcement days over 10,000 sample.

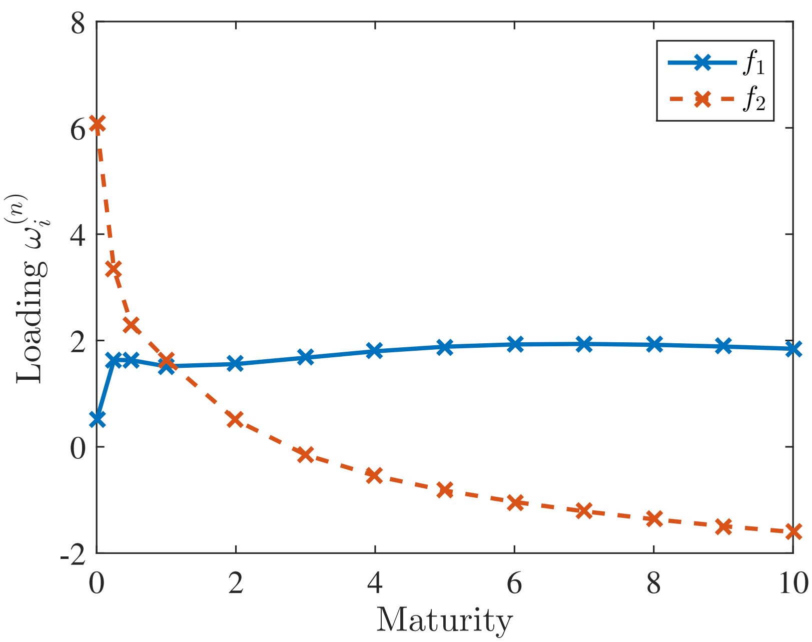
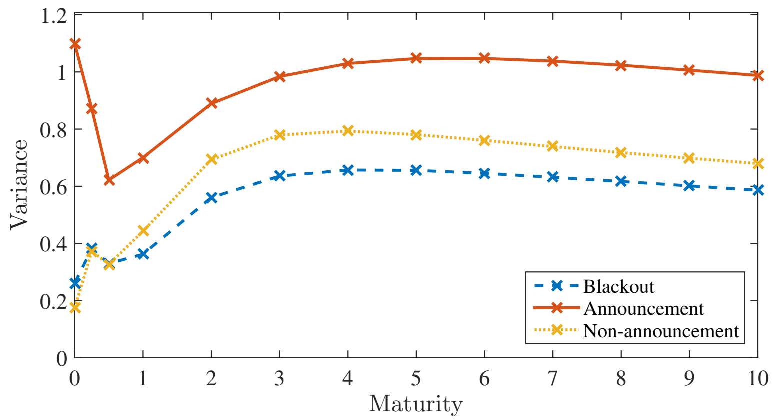


Figure A2: Principal component loading on yields

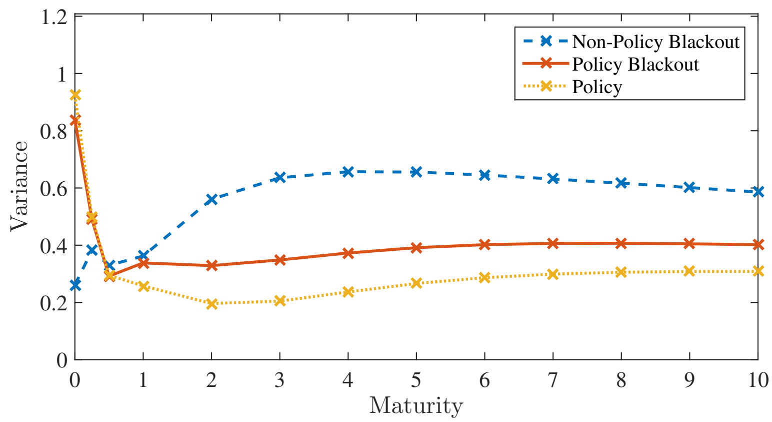
Figure A2 illustrates the loadings on yields of various maturity for the first two principal components of the policy variance matrix.

$$f_{i,t} = \sum_n \omega_i^{(n)} \Delta y_t^{(n)}$$

Maturities are in years where the forward Fed Funds rate is 0.



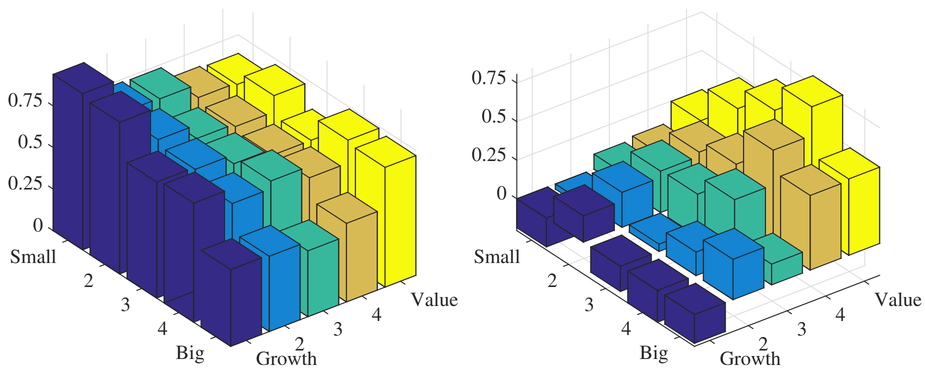
(a) Announcement vs. Non-Announcement



(b) Policy vs. Non-Policy

Figure A3: Comparing variances in the yield curve, including blackout periods

Figure A3 illustrates the variance in yield changes at a range of maturities. Maturities are in years where the zero maturity yield is the change in the front month Fed Funds future. The sample period runs from 1994-2007 and includes 113 FOMC announcement days. Figure 3(a) compares FOMC announcements days versus non-announcement days and versus blackout periods. Figure 3(b) compares policy variance (announcement less non-announcement), blackout policy variance (announcement less blackout) and non-policy (blackout variance).



(a) Factor 1

(b) Factor 2

Figure A4: Covariance of factors with Fama-French 25

Figure A4 illustrates the differential covariance between our factors on announcement days for the FF25 portfolios. Figure 4(a) is the differential covariance of factor 1 on FOMC announcements days versus non-announcement days. Figure 4(b) is the differential covariance of factor 2 on FOMC announcements days versus non-announcement days.

Table A1: Covariance of yields and breakevens with policy factors at weekly frequency

Dep. Var.	(1) 5 year	(2) 10 year	(3) 5 yr BE	(4) 10 yr BE
A	0.30**	-0.71**	-0.09	-0.55
	(0.13)	(0.31)	(0.80)	(0.76)
f_1	30.79***	27.97***	9.15***	7.89***
	(0.15)	(0.33)	(1.20)	(0.94)
f_2	-6.55***	-7.32***	-3.12***	-3.28***
	(0.10)	(0.22)	(0.46)	(0.42)
f_1A	2.64***	0.70	-0.26	-3.52*
	(0.50)	(0.73)	(2.43)	(2.00)
f_2A	-0.22	-2.69***	-0.87	-2.67*
	(0.65)	(0.57)	(1.53)	(1.62)
Observations	707	707	707	707
R-squared	0.99	0.96	0.23	0.24

Table A1 contains coefficient estimates from a regression of changes in Treasury yields (in bps) on changes in our policy factors at a weekly frequency. The interaction terms reveal the covariance between monetary policy announcements and the dependent variable. In Columns 1 and 2, the dependent variable is the nominal yield on the five- and ten-year constant maturity Treasury, respectively. In Columns 3 and 4 the dependent variable is the breakeven yield at the five- and ten-year maturity, respectively. The sample period is from 1999-2007. Standard errors in parentheses are calculated over time using Newey-West (5 lags); * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.